Name *Answer Key*

$$E = E^0 + \frac{0.059\,V}{n} log\frac{[Ox]}{[Red]} = E^o + \frac{2.303RT}{nF} log\frac{[Ox]}{[Red]} \quad \Delta G_{rxn} = -RTlnK_{eq} = -nFE_{cell}$$

R = 8.314 J/mol-K T= 298 K F = 96,500 coulombs/mol V = J/C

$$aA + bB = cC + dD \quad E_{cell} = \left(E^0_{cathode} - E^0_{anode}\right) + \frac{0.059\,V}{n}\, log\frac{[A]^a[B]^b}{[C]^c[D]^d}$$

Quiz 8 (10 pts)
CEM 434
Fall 2016

1. (2 pts). Explain the difference between a potentiometric measurement and a voltammetric measurement.

Potentiometric → measurement of an equilibrium potential established at an indicator electrode vs. a reference electrode. Potential is related to conc. of analyte $E_{IND} \propto \frac{0.0592}{z} \log [X]$

Voltammetric → Control the potential applied to a working electrode and measure the current flow. Current flow is due to a redox reaction

2. (3 pts). In this cell, what is the cathode and what is the anode? What is the cell voltage?

(a) A solution of 0.015M $CuSO_4$ in contact with a Cu electrode (E° = 0.34 V vs. NHE), (b) A solution of 0.25 M $CdSO_4$ in contact with a Cd electrode (E° = -0.403 V vs. NHE), (c) a salt bridge connects to two.

$Cu^{+2} + 2e^- \rightleftharpoons Cu_{(s)} \quad E^o = 0.340\,V \qquad Cd^{+2} + 2e^- \rightleftharpoons Cd_{(s)} \quad E^0 = -0.403\,V$

* Non-standard conditions so Nernst Eq. must be used.

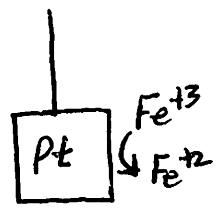
$E_{Cu^{+2}/Cu} = 0.340 + \frac{0.0592}{2} \log \frac{(0.015)}{1} = 0.286\,V$

$E_{Cd^{+2}/Cd} = -0.403 + \frac{0.0592}{2} \log \frac{(0.250)}{1} = -0.421\,V$

* More positive potential = cathode → $E_{Cu^{+2}/Cu}$
* less positive anode = anode → $E_{Cd^{+2}/Cd}$

$E_{cell} = E_c - E_a = 0.286 - (-0.421) = \underline{0.707\,V}$

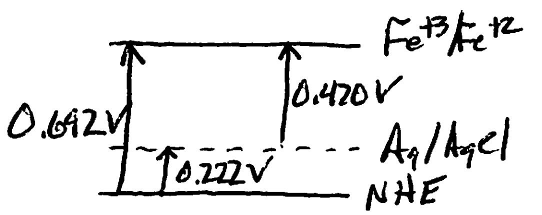
3. (3 pts). In a potentiometric measurement, a Pt indicator electrode was placed in contact with a solution of $[Fe^{+3}] = 0.030$ M and $[Fe^{+2}] = 0.65$ M. ($E° = 0.771$ V vs. NHE). What would be the calculated potential of the Pt electrode vs. the reference? What would this potential be on the Ag/AgCl reference scale? ($AgCl_{(s)} + e^- = Ag(s) + Cl^-_{(aq)}$ $E° = 0.222$ V vs. NHE)



$E° = 0.771$ V vs. NHE $\quad Fe^{+3} + e^- \rightleftharpoons Fe^{+2}$

* non-standard conditions so must use Nernst Eq.

$$E_{Pt} = 0.771 + \frac{0.0592}{1} \log \frac{(0.030)}{(0.65)} = 0.692 \text{ V vs. NHE}$$



$$E_{Pt} \text{ vs. Ag/AgCl} = 0.692 - 0.222 \text{ V}$$
$$= \underline{0.470 \text{ V}}$$

4. (2 pts). At the company you work for, you have been given a new project to disinfect (oxidize) some contaminated water. You are looking to use a chemical method for this and are considering the addition of $Fe_2(SO_4)_3$ to the water supply or bubbling with Cl_2 gas. Which treatment would be predicted to have the greater oxidizing or disinfection power? Write the net redox reaction. Justify your answer.

$Fe^{+3}_{(aq)} + e^- = Fe^{+2}_{(aq)}$ $E° = 0.771$ V vs. NHE $\qquad Cl_{2(aq)} + 2e^- = 2Cl^-_{(aq)}$ $E° = 1.32$ V vs. NHE

Assume: $Bacteria_{(red)} = Bacteria_{(ox)} + e^-$ $E° = 0.00$ V vs. NHE

The stronger oxidizing power would be the more positive redox reaction as compared to the redox reaction for the bacteria.

This would be the Cl_2/Cl^- redox rxns.

Strong oxidant: $Cl_{2(aq)} + 2e^- \rightleftharpoons 2Cl^-_{(aq)}$ $\qquad E° = 1.32$ V vs. NHE

$2\,Bacteria_{RED} \rightleftharpoons 2\,Bacteria_{OX} + 2e^-$ $\qquad E° = 0$ V vs. NHE

$Cl_2 + 2\,Bact_{RED} \rightleftharpoons 2\,Bact_{OX} + 2Cl^-$ $\qquad \Delta E = 1.32 - 0 = 1.32$ V

$$\Delta G = -nFE_{cell} = -(2)(96{,}500 \text{ Coul/mol})(1.32\text{V}) \qquad (C \cdot V = J)$$
$$= -2.53 \times 10^5 \text{ J/mole} \quad \text{(negative thermodynamically favored)}$$